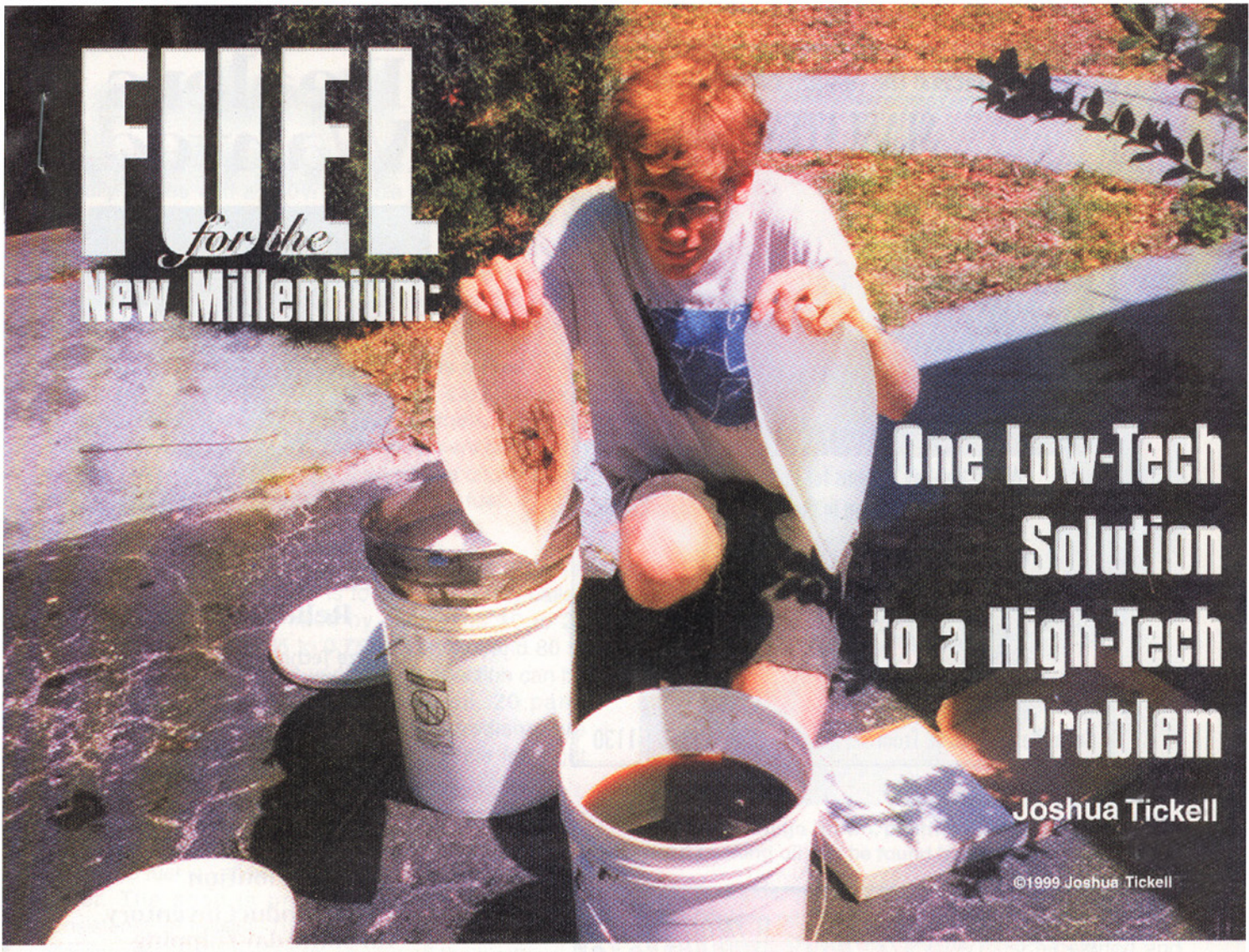
FUEL for the New Millennium:



One Low-Tech Solution to a High-Tech Problem

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Restaurant fryer filters are available at restaurant supply stores and are excellent for filtering food particles out of used cooking oil.

Making your own fuel from vegetable oil can be easy, cost-effective, and environmentally beneficial. What makes this fuel even more attractive is that you can make it from the waste vegetable oil produced in the United States every year, which amounts to more than three billion gallons. With a bit of know-how and persistence, you can run any diesel engine on vegetable oil.

Only diesel engines can run on vegetable oil-based fuels. This means that any engine that has spark plugs and is made for leaded or unleaded gasoline cannot use vegetable oil fuel. If you want a practical homemade fuel for a gasoline engine, you might consider making ethanol, methane, or wood gas.

Grow Your Fuel

We produce a large quantity of used vegetable oil in the United States, but there is an oilseed crop you can grow no matter where you live. The possibilities include coconut, soybean, canola (rapeseed), sunflower, safflower, corn, palm kernel, peanut, jatropha, and hundreds more. To learn which vegetable oil crop is best suited for your area, contact your state's office of agriculture, the agriculture department of a local university, or talk to local farmers.

One of the crops with the highest yield of oil per acre is canola. From just one acre of canola, you can produce 100 gallons (379 l) of vegetable oil. The most common oilseed crop in the U.S. is soybeans, which produce 50 gallons (189 l) of vegetable oil per acre.

Growing your own oilseed crop has an added bonus. The meal that is separated from the oil is an excellent source of protein. This meal can be used as animal feed or in breads, spreads, and other food products.

Pressing the oil from the seed does not require a large, expensive press. TabbyPressen of Sweden makes a

tabletop press for around US$1,000. Although the press usually comes with a 240V/50 cycle electric motor, you can buy the press with a 120V/60 cycle motor from the U.S. distributor. The press looks like a powerful juicer. To operate it, pour the oilseed into the funnel and wait for the vegetable oil to pour out of the bottom. The meal oozes out of the side of the press.

The Three Ways to Use Vegetable Oil as a Fuel

Diesel engines that are found in cars, trucks, generators, boats, buses, trains, planes, pumping stations, tractors, and agricultural equipment can all run on fuel from vegetable oil. Pure vegetable oil, lard, and used cooking oil work just as well as diesel fuel.

Biodiesel

The most conventional method of running a diesel engine on vegetable oil fuel is to produce a fuel called biodiesel. Biodiesel is made by combining 10 to 20 percent alcohol with 0.35 to 0.75 percent lye and 80 to 90 percent vegetable oil. A very reliable reaction can be made with 80 parts new vegetable oil, 20 parts methanol, and 0.35 parts lye. These ingredients are mixed together for an hour and left to settle for eight hours.

After the chemical reaction is complete and the new products settle out, you have biodiesel fuel and glycerin soap. The fuel is yellow to amber in color and flows like water. The soap is brown in color and has the consistency of gelatin. The soap settles to the bottom, allowing you to pump, siphon, or pour off the biodiesel.

Veggie/Kero Mix

The second method for using vegetable oil in a diesel engine is to simply “cut” the oil with kerosene. This method is best suited for emergencies, heavy duty engines, and warm temperatures. Although it is possible to mix other petroleum products with vegetable oil, kerosene is most suited for the diesel engine.

Depending on ambient temperature, the blend of kerosene to vegetable oil will be anywhere from 10 percent kerosene and 90 percent vegetable oil to 40 percent kerosene and 60 percent vegetable oil. A fairly reliable blend is 20 percent kerosene to 80 percent vegetable oil.

The effectiveness and reliability of the veggie/kero method is increased by starting and cooling down the diesel engine on diesel fuel or biodiesel fuel. This can be accomplished by installing an extra fuel tank and switching to the veggie/kero mix when the engine is warmed up.

Straight Vegetable Oil

The third method for running a diesel engine on vegetable oil is to use straight vegetable oil. As with the other methods, you can use either pure vegetable oil or used cooking oil. To ensure the reliability and longevity of your diesel engine, the engine must be started and cooled down on diesel or biodiesel fuel. This also requires the use of an extra fuel tank and a valve to switch between the tank of diesel or biodiesel fuel and the tank of vegetable oil. Think of it as a startup tank and a running tank.

Our friend, Hugo Brown, pouring grease. A container of used cooking oil can be found behind most restaurants.

The key to running a diesel on straight vegetable oil is to heat the vegetable oil at every stage—in the fuel tank, fuel hose, and fuel filter. The vegetable oil must be heated to at least 70°C (160°F).

Most diesel engines have hoses that carry hot coolant. This coolant can be channeled to heat the vegetable oil hoses, tank, and filter. You can make simple modifications to the coolant hoses. These modifications combined with some extra fuel and oil hoses, an extra fuel tank, and an electrically operated switch will allow you to run your diesel engine on straight vegetable oil.

Fuel Comparison

The chart will show you the differences between the three vegetable oil fuel methods. As you can see, biodiesel is a good substitute or additive fuel for diesel fuel. Veggie/kero mix is decent for use as an emergency fuel. And using straight vegetable oil is good if you have the time and know-how to properly modify

Comparison of Different Vegetable Oil Fuel Methods

Property	*Biodiesel*	*Veggie/Kero Mix*	*Straight Veggie Oil*
Can be used as lubrication additive to diesel fuel	yes	no	no
Requires vehicle modification	no	yes	yes
Reliably cuts emissions in all diesel engines	yes	no	unknown *
Considered an alternative fuel under the United States Energy Policy Act (EPACT)	yes	no	yes **
Simple way to run a vehicle in an emergency	no	yes	no
Stable fuel at room temperature	yes	no	no
Requires added chemicals to produce	yes	yes	no
Requires startup tank of biodiesel or diesel fuel	no	yes	yes
Good startup fuel	yes	no	no
Better lubrication than diesel fuel	yes	yes	yes
Gels in cold weather	yes	yes	yes
Covered by many engine warranties	yes	no	no
Can be made from used cooking oil	yes	yes	yes
Can be made from pure vegetable oil	yes	yes	yes
Safe to store and handle, biodegradable, won't spontaneously ignite, and non-toxic	yes	no	yes
Works in all diesel engines	yes	yes	yes
Can be reliably mixed in any proportion with diesel fuel without vehicle modification	yes	no	no
Approved for use by EPACT in a 20% mix with 80% diesel fuel ***	yes	no	no
Engine life, power, torque, fuel mileage, and overall performance are relatively unaffected	yes	yes	yes
Can clog fuel injectors if used improperly	no	yes	yes
Requires heating for operation at any temperature	no	no	yes
Tested and documented by U.S. universities	yes	no	yes
Possible substitute for home heating oil in furnaces	yes	no	no
Can be used in Petromax brand and similar lanterns and stoves	yes	no	yes

* No recent U.S. University studies have been published on this.

** Under EPACT regulations, any biologically-derived fuel is considered an alternative fuel.

*** EPACT legislation states that a fleet must use a minimum of 450 gallons (1703 l) of biodiesel per year.

your engine's heating and fuel tank systems. Diesel engines are used in many different situations. For each situation, there is a way to make fuel from vegetable oil.

How to Make Biodiesel

This section outlines the process for making biodiesel fuel from new vegetable oil or used cooking oil. This fuel can be made in a blender or in a larger, homebuilt mixer. The materials you'll need are vegetable oil, methanol, and lye.

If you are using new vegetable oil, always use 3.5 grams of lye per liter of oil. Since each batch of *used* cooking oil is different, the amount of lye in each batch of biodiesel will be different. To ensure that you are using the correct amount of lye, make a small test batch of biodiesel in a blender before attempting a reaction in a large mixing tank. For the test batch, use 100 milliliters of vegetable oil and 20 milliliters of methanol. Then you must determine how much lye to use.

If you are using used vegetable oil, use 0.45 grams of lye for the first test batch. If this batch makes biodiesel and glycerin, use the same proportions for the large batch reaction. If the test batch does not form two distinct layers, increase the amount of lye to 0.55 grams and make another test batch. If this batch is unsuccessful, make another batch and increase the amount of lye to 0.65 grams. If that batch is unsuccessful, make another batch with 0.75 grams of lye. Make sure you can make biodiesel on a small scale before attempting a large reaction.

Once you have made a successful small test batch of biodiesel, multiply the number of grams of lye you used by ten to see how much lye you will need for each liter of oil in the large reaction. For example, if you used 0.55 grams of lye in the test batch, you will need to use 5.5 grams of lye per liter of used cooking oil for a large reaction.

Here is the basic procedure for making biodiesel fuel. Read the safety information at the end of this article before you begin.

1. Purchase or collect new or used vegetable oil.
2. If the oil is used cooking oil, use a restaurant fryer filter to remove burned food bits, etc.
3. Purchase some methanol alcohol from a local racetrack or chemical supply store. Ethanol alcohol can also be used, but the process is different.
4. Purchase some granulated lye (Red Devil is one brand) or caustic soda sold as a drain cleaner from the hardware or grocery store. It must be pure sodium hydroxide (NaOH).
5. Measure the amount of vegetable oil you want to use in liters. We will call this number V. Pour the vegetable oil into the mixing container.
6. When the temperature is below 70°F (21°C), or when the vegetable oil is solid or lumpy, it will be

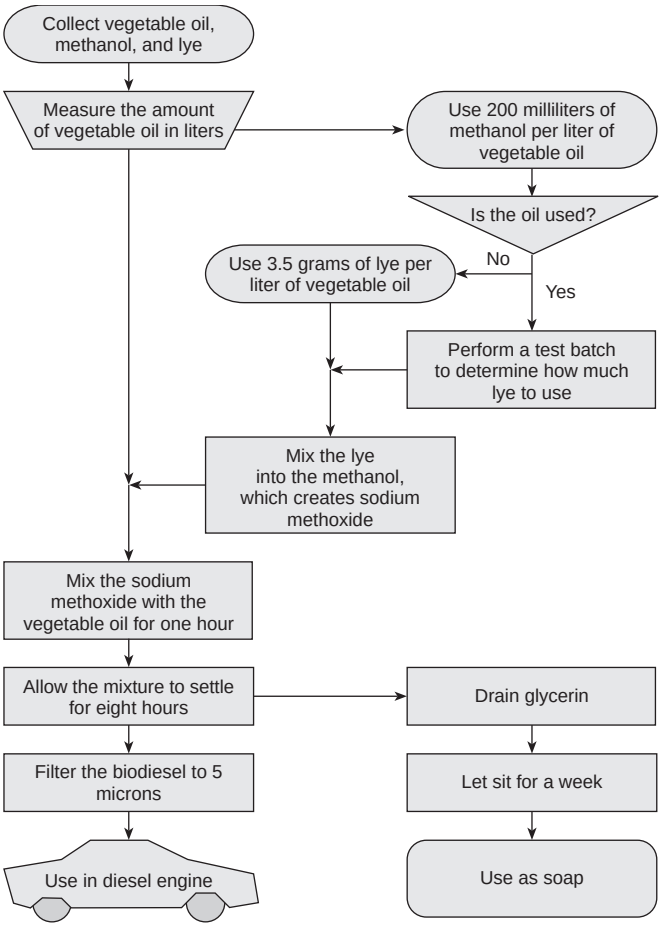
necessary to heat the reactants before, during, and possibly after the mixing. The ideal temperature to attain is 120°F (49°C). A fish tank heater will heat 10 to 30 gallons (40–120 l) of reactants. For larger batches of biodiesel, a water heater element can be mounted in a steel biodiesel mixing tank. Make sure that you follow the manufacturer's directions and safety precautions when adding any electrical device to the system. Be careful when heating vegetable oil in a plastic container. Polyethylene cannot withstand temperatures above 140°F (60°C).

7. Multiply V x 0.2. The result will be the amount of methanol you will need in liters. We will call this number M.
8. To determine how much lye you will need to use for new vegetable oil, multiply V times 3.5 grams. For used vegetable oil, use the number of grams of lye you got in the small test batch. For example, if you used 0.55 grams of lye in the test batch, you will multiply V times 5.5 grams of lye. Call this number L.
9. Carefully pour L grams of lye into M liters of methanol. Stir until the lye is dissolved in the methanol. Be careful, this creates a toxic substance called sodium methoxide.
10. Pour the sodium methoxide into the vegetable oil right away. Stir vigorously for one hour.
11. Let the mixture settle for eight hours.
12. Pump the biodiesel from the top, or siphon it off with a hand siphon. Or if you are lucky enough to have a container with a spigot, open the spigot and drain the bottom layer of glycerin. The glycerin will be much thicker and darker than the top layer of biodiesel.
13. Allow the glycerin to sit in the sun for a week. After that, the trace methanol will be evaporated. You have made a nice glycerin soap. You can scent it with the fragrance of your choice, add other soap agents as desired, or just use it as it is. This soap is especially good for cleaning grease off your hands and cleaning greasy equipment!
14. Make sure your biodiesel goes through a 5 micron filter before entering your diesel engine.

A Simple Biodiesel Processor

The simplest way to make a biodiesel processor is to use a 55 gallon (208 l) steel drum and some sort of mixer. The mixer can be a circulating pump, such as a sump pump, or it can be an electric mixer for chemicals, specially made for drum stirring.

Making Biodiesel Flow Chart



A pump or stirrer will cost about US$200 if you buy it new, but you can build your own instead. With a bit of ingenuity, you can build a biodiesel processor that is inexpensive and effective. Tim Garrits of Kelseyville, California built such a processor from mostly recycled parts for under US$50. A simple biodiesel processor can be built from the following parts:

- A 55 gallon (208 l) metal drum.
- A 1/2 hp electric motor.
- Two pulleys that give about 250 to 400 rpm at the mixer blade.
- A belt that goes around both pulleys.
- A rolled 2 inch (5 cm) rod for the mixer shaft.
- A propeller made from two shelf brackets, welded to either side of the rolled 2 inch rod. The shelf brackets look like two opposed "L"s and form a propeller about 14 inches (36 cm) in diameter. Basically any propeller-shaped metal would do, if it is made from about 12 or 14 gauge steel.

- A 3/4 inch (19 mm) brass ball valve for draining the glycerin.
- A hinge and piece of wood acting as a belt tensioner.
- A 2,000 watt electric water heater element.
- A water heater thermostat.
- Wood, screws, bolts, and other assorted mounting hardware.

A Note of Caution

You are dealing with dangerous chemicals when you make biodiesel. Both methanol and lye are strong bases. They can deaden nerve endings and cause permanent damage. For this reason, chemical resistant gloves, aprons, and eye wear should be worn when dealing with methanol and lye. Shoes, long sleeve shirts, and long pants are a must.

Keep both methanol and lye in clearly marked containers. We recommend putting a skull and crossbones on them and writing something to the tune of "Danger! Toxic! Do Not Eat!" in addition to the contents.

Sodium methoxide, the chemical combination of lye and methanol, is even more toxic than the separate components. Keep this stuff away from any exposed skin. Do not let children play in or around biodiesel equipment. Remember, although you are creating two chemically benign substances when you make biodiesel, you are using dangerous chemicals in the process.

Always keep safety in mind when preparing a biodiesel reaction. Have a faucet or hose nearby. Keep some vinegar handy to neutralize any methanol or lye that may spill. If you take the time to prepare and follow safety guidelines, your biodiesel reaction will go smoothly and you should have no problems.

Fuel Tax & Engine Specifications

If you live in the U.S., you are responsible for paying the IRS for any on-road fuel that is not taxed at the pump. If you live outside the U.S., it would be wise to check with local authorities as to taxation.

You are responsible for any damage that may result to your engine if you use a fuel that does not meet your engine manufacturer's specifications.

Go For It!

Disclaimers aside, biodiesel is used all over the world. Island people are making biodiesel from coconut oil, some countries are experimenting with biodiesel from hemp seed oil, and many others are using canola oil. Millions of miles of road tests have been done with this fuel. Tests have shown less wear on the internal components of engines using biodiesel.

Biodiesel is a reliable, exciting fuel that you can make. If you are worried about your diesel engine, you can install an extra fuel filter system from Racor or a similar aftermarket parts manufacturer. After traveling over 25,000 miles (40,000 km) on biodiesel made from used cooking oil, we continue to choose and recommend biodiesel over toxic, carcinogenic petroleum diesel fuel.

Complete instructions, diagrams, photos, and parts lists for the three methods of running a diesel engine on vegetable oil and building a biodiesel processor are included in the new, second edition of *From the Fryer to the Fuel Tank.*

Access

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New Third Edition! From the Fryer to the Fuel Tank: The Complete Guide to Using Vegetable Oil as an Alternative Fuel by Joshua Tickell, US$29.95 postpaid (outside USA add US$5) to BookMasters, PO Box 388, Ashland, OH 44805 * 800-266-5564 or 419-281-1802 * Fax: 419-281-6883
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